AD-765 679

A METHOD FOR DEVELOPING A CRITERION FOR COMBAT PERFORMANCE OF NAVAL AVIATORS

Maurice Dudley Stanley, Jr.

Naval Postgraduate School
Monterey, California

June 1973

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A METHOD FOR DEVELOPING A CRITERION FOR COMBAT PERFORMANCE OF NAVAL AVIATORS

by

Maurice Dudley Stanley, Jr

Thesis Advisor: R. S. Elster

June 1973

AD-765 679

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Pilot Performance						
Pilot Selection						
Combat Performance						
Combat Behavior						

A Method for Developing a Criterion for Combat Performance of Naval Aviators

by

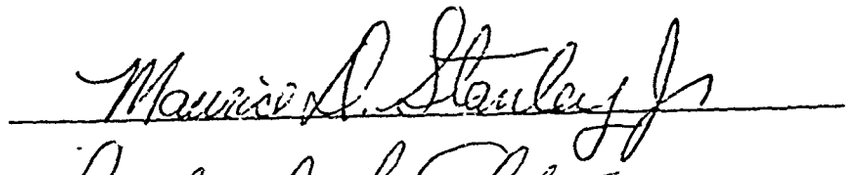
Maurice Dudley Stanley, Jr.
Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1961

Submitted in partial fulfillment of the
requirements for the degree of

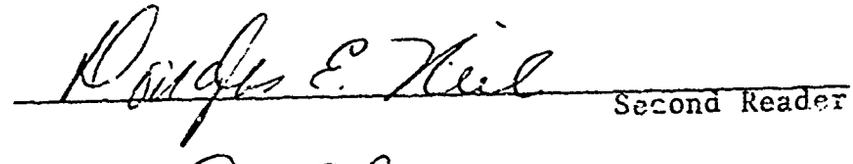
MASTER OF SCIENCE IN MANAGEMENT

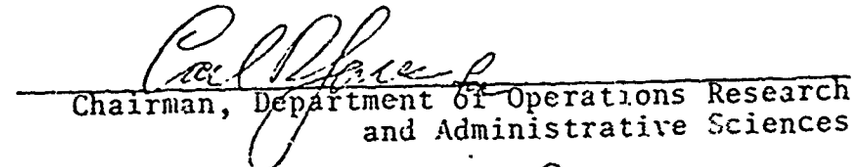
from the

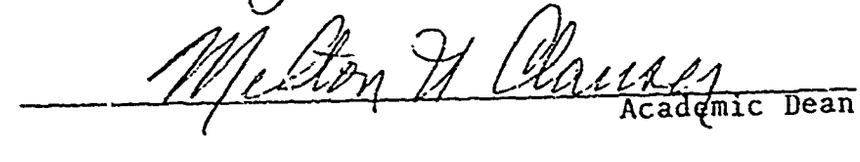
NAVAL POSTGRADUATE SCHOOL
June 1973

Author 

Approved by: 
Thesis Advisor


Second Reader


Chairman, Department of Operations Research
and Administrative Sciences


Academic Dean

UNCLASSIFIED
Security Classification

AD-765 679

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
Naval Postgraduate School
Monterey, California 93940

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
A Method for Developing a Criterion for Combat Performance for Naval Aviators

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Master's Thesis; June 1973

5. AUTHOR(S) (First name, middle initial, last name)
Maurice Dudley Stanley, Jr.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
June 1973	56	22

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO.	
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. DISTRIBUTION STATEMENT
Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Naval Postgraduate School Monterey, California 93940

13. ABSTRACT

Current Naval aviator selection and screening procedures are based on the individual's statistical probability of completing flight training and do not determine the capability of the student to adapt to an operational environment. The resultant failure of some student aviators to complete the advanced stages of training and the ineffective performance of others in operational missions have caused a considerable financial loss and a lessening of combat readiness

A critical incident study, using 30 aviators who have combat experience, indicates that there are 10 categories of behavior which characterize effective and ineffective Naval aviators. Procedures to identify these categories early in flight training are discussed.

DD FORM 1 NOV 68 1473 (PAGE 1)
S/N 0101-807-6811

UNCLASSIFIED
Security Classification

A-31408

ABSTRACT

Current Naval aviator selection and screening procedures are based on the individual's statistical probability of completing flight training and do not determine the capability of the student to adapt to an operational environment. The resultant failure of some student aviators to complete the advanced stages of training and the ineffective performance of others in operational missions have caused a considerable financial loss and a lessening of combat readiness.

A critical incident study, using 30 aviators who have combat experience, indicates that there are 10 categories of behavior which characterize effective and ineffective Naval aviators. Procedures to identify these categories early in flight training are discussed.

TABLE OF CONTENTS

I. INTRODUCTION

The production of qualified effective combat pilots at a minimum cost is an objective of any military flight training activity. The U.S. Navy currently bases its selection and secondary screening procedures on the individual's statistical probability of successfully completing flight training. Very little emphasis is given to determining the individual's capacity to adapt to the post-training environment of operational aviation.

Operational Naval aviation includes a wide spectrum of tasks. These tasks range from the transport pilot whose job is to provide dependable logistic support in secure areas, to the carrier based attack or fighter pilot whose task is to inflict damage on the enemy in a combat situation. A logical division of the tasks of operational aviation is combat and non-combat. Specifically, combat pilots will be considered to be those pilots whose mission is to operate their aircraft as a weapons system in an environment which includes a threat of enemy opposition. Combat missions include attack, fighter, reconnaissance, and some search and rescue and electronic warfare missions. Non-combat pilots are those who perform a combat support role and who would not normally operate in a hostile environment. Examples of non-combat missions are: logistic transport, antisubmarine warfare, radar early warning, and some search and rescue.

It is reasonable to assume that a pilot who is competent in a non-combat role may not be capable of operating a complex weapons system in a hostile environment. The present Navy selection and screening policies do not appear to recognize this important difference. The purpose of this project is to devise a criterion with which effective combat performance can be predicted. Previous research on aviator performance has centered on either success or failure in flight training or on evaluation of effectiveness on completion of flight training. In order to be of maximum usefulness, such criteria should be capable of identifying those individual student pilots who are potentially combat effective while they are in the very early stages of training. Such a system of early identification would not allow the use of a large number of flight training grades as a predictor. The approach taken in this project is to identify those categories of behavior which characterize effective and ineffective combat aviators. If such traits can be identified, and procedures to identify them in flight students can be devised, at each stage of training the individual student can be directed toward that mission for which he is best suited. This would not only eliminate the expense of the attrition of misplaced students but would also increase the combat effectiveness of the operational units to which prescreened graduates are assigned.

II. THE PRESENT NAVAL AVIATION SELECTION AND SCREENING SYSTEM

In the initial selection process Naval aviation candidates are tested in five major areas: intelligence, physical fitness, psychomotor skills, mechanical comprehension, and background information. There are also the basic requirements of age (less than 26) and a college degree. With the exception of the physical examination and the basic requirements, these attributes are measured by pencil and paper or apparatus tests. The results of these tests are correlated with the pass-fail dichotomy for the entire training command, regardless of the ultimate employment of the aviators.

The physical examination includes, in addition to the usual tests of physical fitness, visual acuity, etc., an interview with a Naval Flight Surgeon. The purpose of the interview is to appraise the candidate's likelihood of completing flight training. As an example of the lack of relationship of this evaluation to the ultimate task of the applicant, the U.S. Naval Flight Surgeon's Manual [1] includes the following guidance:

> It is reasonable to suppose that any healthy, red-blooded, interested American boy of normal intelligence and social skills should be able to learn to fly the Navy's aircraft completely.

After a flight student has commenced training, he enters a secondary screening system which predicts his probability of completing flight training based on his

flight and ground school grades [2]. This system was constructed by taking all of the grades assigned to 2648 students and establishing, at different points in training, the correlation of these grades to the pass-fail dichotomy. This matrix of correlations was used to develop a linear prediction equation for each point in time. This system is designed for, and used principally by, training administrators in making dispositions of students who have encountered training difficulties.

One of the most important selections, with respect to the student pilot's ultimate mission, occurs at the end of primary flight training. At this point, the student enters either the propeller or jet training "pipeline" for basic and advanced training. This selection is significant in that the majority of the students entering the jet pipeline will ultimately be assigned to combat missions while those assigned to the prop pipeline will be assigned to non-combat missions. This selection is made primarily by using the grades received on the first 12 training flights. Academic grades are used for tie breakers.

On a weekly basis, the students who complete primary training with the highest grades are accepted in the jet pipeline, if they desire jet training. The cutoff grade is variable, depending on the number of students who desire jet training and the number who can be accepted by the jet basic training squadrons. This number of openings is highly variable depending on such factors as the previous

weather conditions and aircraft or instructor availability at the jet training bases. Those students not desiring or not accepted for jet training are automatically assigned to the propeller pipeline.

One evaluation of the effectiveness of this system is presented in a report prepared by the Naval Aerospace Medical Research Laboratory (NAMRL) [3]. A survey was conducted of flight surgeons attached to all deployed operational Navy squadrons. Fifty-six percent of the flight surgeons responded. These flight surgeons identified 144 aviators as having unsatisfactory combat performance. The following breakdown of data obtained concerning these aviators yielded:

24 men with whom other pilots refused to fly
43 men who turned in their wings
32 men who had their wings removed by Board action
22 men who were transferred administratively
23 men who were given non-flying duties

It is noteworthy that at the time of this survey a large percentage of Naval aviation units were engaged in combat operations in Southeast Asia.

This report does not identify these aviators by mission, nor does it give the size of the population from which it was drawn. However, this number of unsatisfactory aviators probably represented a significant loss of combat effectiveness for deployed aviation units.

A more specific study of potential aviator combat effectiveness was conducted by the same organization by studying the performance of newly designated aviators in the jet Replacement Air Groups (RAG's) [4]. RAG training

is that phase of a Naval aviator's career when he transitions from a training environment to an operational environment. A RAG student is taught by instructors with fleet experience in operational aircraft and upon graduation should be fully qualified to perform the mission of the operational squadron to which he is assigned.

During a one-year period (November 1966-November 1967), of 592 newly designated aviators assigned to jet RAG's, 13%, or 78 aviators, were attrited for reasons other than medical, personal hardship, disciplinary action, or death. This percentage exceeds the 8% attrition rate predicted by the Student Pilot Prediction System for all student pilots assigned to the jet pipeline in basic training.

The financial impact of this loss is considerable, as the average cost per student completing jet training is $129,183.00 and the average cost per student for RAG training is $163,776.00 [5]. The attrition of 78 aviators represents an annual loss of between $10,086,274.00 and $22,850,802.00, depending on the degree of completion of the RAG at the student's attrition.

III. RELATED RESEARCH

The problem of predicting military aviator effectiveness or success has been explored extensively since the first use of aircraft as weapons systems in World War I. The earliest selection procedures were based on physical examinations to ensure that the aviators had no physical defects. The British Royal Flying Corps reported that of each 100 aviators killed during the first year of its participation in World War I, 90 had died because of their own "individual deficiencies," and of these, 60 were found to have been directly due to "physical defects" [6]. Subsequent research during this period described tests of mental alertness, reaction time, judgment of the speed of moving objects, reasoning, choice reactions, equilibrium differential, and tilt perception. However, very few of these tests were evaluated adequately and their predictive validity was in doubt. The psychologists of the period recognized the need for satisfactory evidence of the validity of such tests as a basis for acceptance of their utility for selection [7].

In the period between World War I and World War II, aircrew selection research included coordination and psychomotor tests, personality measures, and ability tests. Naval research by A. Ickstadt and D. G. Sutton [8] drew attention to the low correlation of rigid physical standards with actual ability to fly an aircraft. Their conclusion was

that psychological examinations should be used to determine aeronautical adaptability. Sutton specifically called attention to the need for properly trained flight surgeons, saying that medical officers having a superficial knowledge of psychology were a liability rather than an asset. He also stressed the need for follow-up and validation studies on a large number of pilots. J. C. Flanagan, who conducted research for the U.S. Army Air Forces during this period, summarized the past work on pilot research as follows [9]:

> In summary, it can be said that in the summer of 1941 there was evidence from a number of samples that certain apparatus tests and possibly one or two paper-and-pencil tests had predictive value for success in pilot training. However, the samples for the recently tested populations tended to be small and the results not entirely consistent. Much additional research seemed necessary before a satisfactory procedure for selecting pilots could be based on established relationships.

During World War II substantial contributions were made to aircrew selection procedures. The Army Air Forces developed the Aviation Cadet Qualification Examination which gave separate aptitude scores for pilot, bombardier and navigator. This test was designed to measure aptitude rather than specific knowledge obtained through formal education or training. Subsequently the Aircrew Classification Battery was developed to differentiate between aptitude as a pilot, bombardier, navigator, or flight engineer. This battery consisted of four apparatus tests of coordination and reaction speed and 14 paper-and-pencil tests. This battery had a validity of approximately 0.50 with the pass-fail dichotomy in primary training [10].

During the early part of World War II the Navy developed the Flight Aptitude Rating (FAR). The FAR included an intelligence test, a mechanical comprehension test, and a background inventory. In 1942 the FAR had a validity of 0.50 in predicting training success [11]. An updated version of the FAR is still being used to screen applicants for Naval Flight Training. The current version consists of a mechanical comprehension test, a spacial apperception test, and a background inventory. The FAR is used in conjunction with the Aviation Qualification Test (AQT) which is a general intelligence test. With a minimum AQT stanine score of 3, the FAR predicts a completion rate of from 50% of those applicants with a FAR stanine score of 3 or 4, to a 90% predicted completion rate for those with a FAR stanine score of 9 [12].

The use of the pass-fail dichotomy as the primary criteria for selection and screening of flight students has continued, not only in the Navy as previously described, but in other services. One of the more interesting applications of this criterion is reported by Jessup and Jessup [13] in which the British Royal Air Force used the Eysenck Personality Inventory to predict pilot training success. In this study significant differences were found in the failure rates of people falling in the four quadrants of the Neuroticism/ Extroversion personality space.

Subsequent to World War II, research has been conducted on the combat effectiveness of pilots. One of the earliest

efforts in this field was made by Douglas Bond, who as a psychiatrist with the Army Air Forces observed several thousand healthy and many emotionally disturbed aviators. These observations of combat aviators led to his classic work, The Love and Fear of Flying [14]. While Bond deals largely with those pilots who "broke" in combat, he associates certain psychological characteristics with those aviators who are particularly successful in combat. He attributes their success to the gratification of some unconscious aggressive and libidinal drives which are evidenced by their delight in expressing aggression in the air and their love of flying. He also comments on the difficulty of identifying men who have these drives.

During the Korean Conflict, Trites and Sells [15] attempted to correlate combat performance and training data for a group of U.S. Air Force pilots who had taken a battery of tests at the beginning of flight training. While most of their correlation coefficients were insignificant, an examination of their findings indicates that a psychological rating based on all of the data available on an individual while he was in flight training was significantly related to the mean of combat peer/superior ratings ($r = 0.32$) and this rating had a correlation with total number of combat flight hours of 0.36.

An Air Force study was conducted in Southeast Asis in 1967 to determine the effects of training on F-4 second-seater combat performance [16]. Among the results, it was

concluded that a task inventory could be utilized to determine the effects of training programs on combat performance. It could not be determined if this technique has been used in further research on pilot combat performance.

In the previously cited study by the Naval Aerospace Medical Research Laboratory (NAMRL) using a survey of flight surgeons, of the 17 selection and training variables available for the aviators identified as having unsatisfactory combat performance, only the peer rating had possible value in predicting combat performance.

In the study of Replacement Air Group (RAG) performance by Bale, Rickus and Ambler [4], it was found that certain grades assigned in flight training were significantly related to pass-fail dichotomy in the RAG. A regression analysis of these grades resulted in a predictor equation with a correlation of 0.359 with success or failure in RAG training. A predictor score was identified that would have eliminated 41.4% of the unsuccessful RAG students and only 6.9% of the successful ones. This would have reduced the RAG input by 11.5% but would have reduced the attrition rate to 8.8%, or approximately that of students in the jet pipeline. While this represents a substantial saving in the cost of RAG training, the cost of training the 68 pilots who would not be accepted for RAG training would still be lost unless other employment, in an aviation community in which they would be successful, could be found.

Additional development of an operational criterion for the F-4 fighter community has been done by R. H. Shannon, W. L. Waag, and J. C. Ferguson of NAMRL [17, 18, and 19]. In their first study it was found that only five flight items graded in the RAG accounted for 70% of the variance of the final RAG grade. The multiple correlation of these items with the final grade was 0.839. For a further study, 14 items, which had a multiple correlation of 0.852 with the final grade in the East Coast F-4 RAG, were used to predict the final grades for students in the West Coast F-4 RAG. The resulting correlation between predicted and observed grades was 0.776. As a result of these studies, a rating form consisting of two criterion measures was conducted and sent to the Commanding Officers of operational F-4 squadrons.

The squadron Commanders were asked to rate the pilots, on which RAG and training data had been compiled, on 17 significant items determined from the RAG studies and on critical incidents; i.e., accidents, ramp strikes, wings pulled, or other serious incidents. The individual results on the 17-item rating were transformed to a standardized Fleet Rating Score. A regression analysis for the Fleet Rating Score resulted in a prediction equation containing 12 variables which were grades assigned in training or the RAG, and which had a cumulative multiple correlation coefficient 0.476. However, only two of these variables, Flight Aptitude Rating (FAR) and Primary Flight Grade, would have

been of use in determining fleet performance in the early stages of training, and these variables ranked as eight and twelfth in importance.

Of the 101 pilots for whom critical incident information was obtained, 25, or 24.8%, were "credited" with an incident. The regression analysis for this dichotomous criterion resulted in a prediction equation containing eight variables having a correlation of 0.297. FAR ranked as the fourth variable behind four RAG grades. The correlation between the Fleet Rating and critical incident criteria was -.400. While the sign of the correlation was in the expected direction, its rather low magnitude seemed to suggest that adequate operational flight performance in the F-4 (as defined by the Fleet Rating Score) may not necessarily be the same as adequate safe performance (as defined by the lack of critical incidents).

In summary, while extensive research has been conducted on the selection and screening of military pilots, the use of an operational effectiveness criterion is a relatively recent procedure. The current state of this research, as represented by Shannon and Waag, is based on using data such as flight grades as predictors. While the correlation of these grades with operational performance is significant, the variables which explain most of the variance in the operational performance criteria are not available until the later stages of aviator training. This situation will not eliminate those students who fail to complete training

because of misplacement or who are subsequently detected as ineffective upon completion of training.

IV. METHOD

In order to identify those pilot characteristics which are associated with effective or ineffective combat aviators, a critical incident procedure [20] was used in this project. This procedure was chosen because it would allow descriptions of a relatively wide latitude of behavior without using a specific definition of combat effectiveness. This technique would also eliminate the restrictions or bias of a task-oriented questionnaire.

Combat effectiveness is a many-faceted concept, having different meanings for different individuals. A specific definition of combat effectiveness would either reflect the bias of the individual making the definition or would be virtually impossible to formulate using all of the individual definitions available. For this reason, a specific definition was not used in this project. The behavioral characteristics which evolved from using this method should be representative of those associated with a general concept of combat effectiveness.

The subjects for the experiment were 30 aviators from the student population of the Naval Postgraduate School. All of the subjects were volunteers. The only requirement to participate was that each subject must have had combat experience. All but one of the subjects were U.S. Navy pilots or flight officers with combat experience in Southeast Asia. The other subject was an Israeli Air Force

officer who had participated in the Six Day War in 1966 and in subsequent combat operations. The following is a breakdown of the subjects:

Rank (at the time of the incident)	CDR (05): 4 (Includes Israeli Officer) LCDR (04): 6 LT (03): 11 LT(jg) (02): 9
Mission	Fighter (VF): 9 Attack (VA, VAH): 10 Helicopter Attack (HAL): 3 Electronic Warfare (VAQ, VQ, VAW): 3 Antisubmarine Warfare (VP, VS, HS): 4 Reconnaissance (RVAH): 1

The average number of combat missions for all subjects was 178; the high was 600 and the low was 25.

An interview form (Appendix A) was constructed and used by the interviewer in each case. The purpose of this form was to ensure continuity of the information requested from interview to interview. Each subject was given a copy of the form so that he could read the instructions and refer to the items during the interview.

After each subject had read the instructions and any questions had been answered, he was asked to describe an incident in which he had observed a pilot demonstrate particularly effective combat performance. The interview was conducted in an informal atmosphere and the subject was encouraged to present his own opinions on why the performance was particularly effective. If the subject did not discuss why the individual's behavior or personality was effective he was asked to comment specifically on this point.

The same procedure was used to describe an incident in which a pilot demonstrated particularly ineffective performance. Rank and organization position were recorded for the pilots described and personal data were recorded for the subject. The entire interview was tape recorded for further study.

To define those types of behavior which characterized effective and ineffective combat pilots, four Naval aviators, two with combat experience and two without, listened to 14 of the taped interviews and independently compiled a list of the behavior mentioned in each case and the number of cases in which each type of behavior was mentioned. When this task was finished, a conference was held with the four raters to resolve any semantic differences and a list of eight categories of behavior which characterized effective pilots and nine categories which characterized ineffective pilots was constructed.

A rating form using these categories was constructed. This form is shown in Appendix B. Three additional raters listened to the tapes of the interviews and rated each interview using this form. The behavior indicated in each interview was assigned to a category if the rater thought the behavior was an example of the behavior described by the category. For each interview any number of the categories could be designated as descriptive of the behavior described in the interview. If the behavior could not be described by one of the given categories it was listed specifically on

the form. Each category was marked only once for each interview and categories describing ineffective aviators were not allowed if the subject had designated the aviator described in the interview as effective and vice versa. The raters for this procedure were Navy attack or fighter pilots with combat experience.

An analysis of the data was conducted to determine the number of times each category was observed by one, two or all three raters and the percentage of the total number of categories observed accounted for by each category. The percentage of the times that each category was marked by all three raters was also calculated as a measure of how well that category could be identified and utilized by raters. A rating for each category was calculated by the following formula:

Rating = Percentage of Total X Percentage Unanimous X 1000

Where percentage of total was calculated by dividing the individual category total by the total number of all categories marked, and percentage unanimous was calculated by dividing the number of times an individual category was identified by all three raters by the individual category total. This information is tabulated in Tables 1 and 2 for effective and ineffective aviators, respectively.

Excerpts from the interviews describing the specific behaviors which were identified unanimously, by category, are given in Appendix C.

CATEGORY	RATER AGREEMENT 3 of 3	2 of 3	1 of 3	Category Total	Percentage of Total	Percentage Unanimous	Rating
1. Decision Making Capacity	4	0	7	11	10.70%	36.4%	39.0
2. Determination	7	4	6	17	16.50%	41.2%	68.0
3. Situation Awareness	9	7	6	22	21.40%	40.9%	85.5
4. Stress Capacity	9	3	3	15	14.55%	60.0%	87.3
5. Procedural Ability	8	3	9	20	19.41%	40.0%	77.6
6. Self Confidence	1	2	2	5	4.85%	20.0%	9.7
7. Concern	1	3	2	6	5.80%	16.7%	9.7
8. Communication	2	0	1	3	2.91%	66.7%	19.4
					96.12%		
Other							
Professionalism	0	0	1	1	.97%	0	0
Comprehensive Brief	0	0	1	1	.97%	0	0
Good Airmanship	0	1	0	1	.97%	0	0
Good Preparation	0	0	1	1	.97%	0	0
TOTAL	41	23	39	103	100.00%		

BEHAVIORAL CATEGORIES FOR EFFECTIVE COMBAT PILOTS

TABLE 1

CATEGORY	RATER AGREEMENT 3 of 3	2 of 3	1 of 3	Category Total	Percentage of Total	Percentage Unanimous	Rating
1. Poor Decision Making Capacity	12	2	5	19	18.10%	63.2%	113.5
2. Fixation	6	1	1	8	7.60%	75.0%	56.9
3. Lack of Situation Awareness	8	2	8	18	17.25%	44.5%	75.7
4. Poor Stress Capacity	2	3	0	5	4.76%	40.0%	19.1
5. Procedural Violations	8	5	3	16	15.22%	50.0%	76.2
6. Over Confidence	2	3	1	6	5.71%	33.3%	19.2
7. Lack of Concern	2	3	2	7	6.67%	28.6%	19.0
8. Lack of Preparation	4	1	6	11	10.48%	36.4%	38.2
9. Excessive Concern with Self Image	3	2	3	8	7.61%	37.5%	28.6
					92.40%		
Other							
Lack of Aggressiveness	0	0	1	1	.94%	0	0
Lack of Training or Experience	0	0	1	1	1.90%	0	0
Inconsistent	0	0	1	1	.94%	0	0
No Faith in Crew	0	0	1	1	.94%	0	0
Poor Airmanship	0	0	1	1	.94%	0	0
Lack of Confidence	0	0	1	1	.94%	0	0
TOTAL	47	22	35	104	100.00%		
Percentage	44.8%	20.9	34.3%	100%			

BEHAVIORAL CATEGORIES FOR INEFFECTIVE COMBAT PILOTS

TABLE 2

V. RESULTS

The categories on the Behavior Rating Form which were identified by the first four raters account for 96.12% of the behavior attributed to effective combat aviators and 92.40% of that attributed to ineffective combat aviators by the 30 subjects. The remainder of the behavior was identified as "other" on the Behavior Rating Form, as indicated on Tables 1 and 2. These percentages indicate that combat performance may be assessed by evaluating relatively few aspects of an individual's behavior.

Seven of the categories which describe effective or ineffective combat performance represent opposite, or at least significantly different performance in the same behavioral area. When these categories are combined, and the ratings added, 10 categories result which can be ranked as in Table 3.

The results in Table 3 indicate that some of the combined categories tend to be indicative of effective aviators and others indicative of ineffective aviators. Thus, the ability to function effectively in stress situations and to communicate efficiently is more indicative of effective aviators than the lack of these abilities is reflective of ineffective aviators. By the same reasoning, poor capacity for making decisions, lack of preparation, and excessive concern with self-image are more indicative of ineffective combat aviators. The remaining categories--situation awareness,

	RATING			
	Effective	Ineffective	Total	Rank
Situation Awareness	85.5	76.7	162.2	1
Procedure Ability	77.6	76.2	153.8	2
Decision Making Capacity	39.0	113.5	152.5	3
Determination/ Fixation	68.0	56.9	124.9	4
Stress Capacity	87.3	19.1	106.4	5
Lack of Preparation	--	38.2	38.2	6
Excessive Concern with Self Image	--	28.6	28.6	7
Self Confidence/Over Confidence	9.7	19.2	26.9	8
Concern	9.7	19.0	26.7	9
Communication	19.4	--	19.4	10

RANK ORDERING OF TOTAL RATINGS

TABLE 3

procedural ability, determination or fixation, the extent of confidence and the ability to relate to the mission--can be applied about equally to effective and ineffective combat aviators.

The five combined categories with the highest total ratings appear to be significantly more important in describing combat performance than the remaining five categories. An accurate evaluation of a student pilot's situation awareness, procedural ability, decision making capacity, determination or fixation, and stress capacity should provide an indication of his potential combat performance.

An additional interesting result of this project is the rank distribution of the effective or ineffective pilots described in the interviews. This distribution is shown in Table 4. While Commanders accounted for 16.7% of the effective combat pilots, which is approximately their percentage of the population of Naval aviators, they represented 32.1% of the ineffective combat pilots. While a sample size of 30 is too small to make a statistical inference from this information, there does not appear to be a logical explanation for the difference. Commanders who would have been observed in combat are assigned as Air Group Commanders or Squadron Commanding Officers and Executive Officers and have been screened by the Bureau of Naval Personnel for these jobs. On this basis and their experience level they should be expected to represent a larger percentage of the effective combat pilots than of the ineffective pilots. This area appears to warrant additional research.

	Effective	Ineffective
Commander	5	9
Lieutenant Commander	8	8
Lieutenant	9	8
Lieutenant (junior grade)	6	2
Unknown	2	1

RANK DISTRIBUTION OF OBSERVED COMBAT PILOTS

TABLE 4

VI. DISCUSSION OF RESULTS AND RECOMMENDATIONS

The results of this project indicate that a relatively few behavioral categories appear to be required to describe the combat performance of effective or ineffective Navy combat pilots. An evaluation system based on the early identification of these behaviors in student pilots should not only eliminate a substantial part of the expense of training pilots who subsequently fail because they cannot adapt to the operational environment, but should also improve the combat readiness of those squadrons which have a combat mission. Those students who are not evaluated as potentially combat effective and who successfully complete flight training could be utilized in the many essential non-combat missions of Naval Aviation.

The evaluation of a student pilot's combat potential should be completed prior to his assignment to the jet or propeller training pipelines. The result of this evaluation, used in conjunction with primary flight grades, would ensure that those students assigned to jet training not only have adequate flight proficiency but also are potentially effective in the operational environment for which they are being trained. The assignment of students with excellent flight grades but who are not potentially combat effective to propeller training would raise the flight proficiency level of junior pilots in non-combat missions.

Using the behavioral categories defined in this project, two types of tests could be used to evaluate a student pilot's combat effectiveness. The two types are pencil-and-paper situational tests.

Multiple choice, pencil-and-paper tests could be constructed to measure decision making capacity and the importance of self-image. These tests should ask "What would you do?" in a number of hypothetical situations. The answers would give a choice of actions which represent different levels of logic or concern with self-image. The following is an example of a question which Armstrong [21] suggests would measure decision making capacity.

> A pilot has made a forced landing near a mountain cabin. He finds that the nearest phone is at an isolated ranger's cabin 14 miles across the mountains to the north. It is winter. He sets out on foot for the ranger's cabin at 6 a.m., carrying enough food for only one meal. At 10 a.m., having met no one, he comes to three branches of the trail, all unmarked. It would be best for him to
>
> a. Follow the trail that appears to lead in the right direction until he reaches the cabin or the end of the trail.
>
> b. Turn back immediately toward his starting point.
>
> c. Leave the trail and go due north by compass.
>
> d. Walk until noon along the trail that appears to lead in the right direction; then turn back if not sure of his location.
>
> e. Stay at the fork in the trail and wait for someone to come by.

Situation testing could take a variety of forms. One method of testing behavior and personality in the pre-flight phase of training would be to include the escape and evasion and prisoner of war compound segments of survival training

in pre-flight survival training. These segments are currently being conducted in the Replacement Air Group. The escape and evasion segment consists of having the student evade "agressor" forces while making his way to a designated objective. If he is captured he should try to escape if the opportunity presents itself. In this scenario the student's stress capacity, determination or fixation, situation awareness, and level of confidence could be evaluated by observers trained to recognize these categories. The prisoner of war compound segment consists of a simulated prisoner of war camp environment in which a group of students must resist harsh interrogation, establish an effective organization, and attempt to escape, if possible. This segment offers an opportunity to evaluate the students' stress capacity, confidence, and concern.

Another method in which situation testing could be accomplished is by having the student's primary flight instructors rate him in each category. While each student is assigned to a specific instructor he is required to fly a minimum number of training flights with other instructors. This requirement should eliminate any bias his assigned instructor may have. In addition to rating the student on the other traits the flight instructors could evaluate his procedural ability, preparation for flights, and communication ability.

An example of a rating form which could be used in situational testing is given as Appendix D. This form

defines each category as it characterizes effective or ineffective combat performance and allows the rater to select an intermediate level of performance if such is indicated. Before using such scales, behavior typical of each level of performance should be described on the rating form. A procedure for scaling behavior in such a fashion is outlined in Dunnett's Personnel Selection and Placement [22].

For the foreseeable future the primary mission of the U.S. Navy will be training for combat operations. The current reduction in funds and personnel and the rising cost of aircraft weapons systems make it even more important that potential aviator combat performance be evaluated, and those who are predicted to be ineffective be eliminated or otherwise employed as early as possible. The system described in this project, using experiences gained in actual aerial combat to identify those behavioral and personality traits which characterize effective and ineffective combat aviators, will allow such early identification. In the future the Navy will have fewer aircraft, both combat and combat support, and in the event of hostilities the pilots who man them will have to be the best available.

defines each category as it characterizes effective or ineffective combat performance and allows the rater to select an intermediate level of performance if such is indicated. Before using such scales, behavior typical of each level of performance should be described on the rating form. A procedure for scaling behavior in such a fashion is outlined in Dunnett's Personnel Selection and Placement [22].

For the foreseeable future the primary mission of the U.S. Navy will be training for combat operations. The current reduction in funds and personnel and the rising cost of aircraft weapons systems make it even more important that potential aviator combat performance be evaluated, and those who are predicted to be ineffective be eliminated or otherwise employed as early as possible. The system described in this project, using experiences gained in actual aerial combat to identify those behavioral and personality traits which characterize effective and ineffective combat aviators, will allow such early identification. In the future the Navy will have fewer aircraft, both combat and combat support, and in the event of hostilities the pilots who man them will have to be the best available.

APPENDIX A

INTERVIEW FORM

I am conducting a study of effective combat aviators in order to identify them early in flight training. I feel that the best judges of combat effectiveness are aviators with combat experience. Therefore, I am asking you to use your expertise to assist me in both defining combat effectiveness and identifying characteristics of effective combat aviators.

The information you give me will be treated as strictly confidential. You do not have to use names of other pilots, but if you do they will not be reproduced in any record other than this one, which will be destroyed after the information has been extracted.

1. Think of an incident in which you have observed a pilot demonstrate particularly effective combat performance. This should be in a hostile environment, although active enemy opposition is not required (i.e., the mission was over the beach or in contact with the enemy).

   Describe the incident as completely as you can. Include:

   a. Location
   b. Time (day/night)
   c. Weather
   d. Briefed mission
   e. Your position
   f. Your impression/feelings at the time
   g. Danger level

2. Why was this pilot's behavior particularly combat effective?

3. What was this pilot's rank and position in the squadron?

4. Think of an incident in which you observed a pilot demonstrate particularly ineffective combat performance. The same criteria apply.

Describe the incident as completely as you can. Include:

a. Location
b. Time (day/night)
c. Weather
d. Briefed mission
e. Your position
f. Your impression/feelings at the time
g. Danger level

5. Why was this behavior ineffective?

6. What was the pilot's rank and position in the squadron?

7. I will need some background information on you.

a. Rank and position in squadron at each incident.
b. Pilot/NFO
c. Type aircraft flown.
d. Number of combat/combat support flights.

APPENDIX B

BEHAVIOR RATING FORM

Tape____No.____

EFFECTIVE BEHAVIOR	INEFFECTIVE BEHAVIOR
1. DECISION MAKING CAPACITY: the ability to make logically correct decisions based on the current tactical situation.	1. POOR DECISION MAKING MAKING CAPACITY: the individual either does not make a decision when one is required or makes illogical decisions based on the available information.
2. DETERMINATION: consistency; the ability to follow a course of action to its logical conclusion.	2. FIXATION: concentration on one aspect of the tactical situation to the exclusion of other sensory inputs.
3. SITUATION AWARENESS: the ability to integrate inputs from the environment into an accurate conception of the tactical situation.	3. LACK OF SITUATION AWARENESS: the lack of ability to integrate inputs from the environment into an accurate conception of the tactical situation. The individual does not properly assess the threat or risk of his actions.
4. STRESS CAPACITY: the ability to function logically and effectively in high stress situations, i.e., calm, does not panic, etc.	4. POOR STRESS CAPACITY: the individual does not function logically or effectively in high stress situations, i.e., panics, is excitable, or "clutches."
5. PROCEDURAL ABILITY: the ability to adapt procedures and tactics to the situation in an effective manner.	5. PROCEDURAL VIOLATIONS: the individual violates established procedures or disregards proven tactics with insufficient reason for such deviations.

6. __SELF CONFIDENCE: confident in his own abilities but not to the extent of conceit.	6. __OVER CONFIDENCE: the individual over-estimates his own abilities to the point of exceeding his capabilities in a tactical situation.
7. __CONCERN: the ability to relate to the mission or to the individuals involved in the tactical situation.	7. __LACK OF CONCERN: the inability to relate to the mission or to the other individuals involved in the tactical situation.
8. __COMMUNICATION: the ability to transmit timely, accurate and concise information.	8. __EXCESSIVE CONCERN WITH SELF IMAGE: the individual is overly concerned with trying to impress others to the extent that his ability to make tactical decisions is impaired.
	9. __LACK OF PREPARATION: the individual is not prepared for the mission, i.e., lack of tactical intelligence, poor navigation planning, etc.
OTHER: _____	OTHER: _____
_____	_____
_____	_____
_____	_____

APPENDIX C

NARRATIVE EXCERPTS DESCRIBING EFFECTIVE AND INEFFECTIVE COMBAT BEHAVIORS

I. EFFECTIVE PERFORMANCE

A. Decision Making Capacity

"He reacted immediately. He didn't have to think."

"He took command of the Army helicopters, and guided the boats by using the searchlights."

"On the spot he made the decision not to bother about the runway at all but to make as many strafing passes as he could."

"We were with somebody who had some initiative, who would do something...It was questionable at the time if it was within the rules of engagement."

B. Determination

"He went and did the job, got the rig and the pictures."

"He told me over the radio in no uncertain terms that he was my wingman and he was going to stay with me."

"He didn't have it in his head to bail out... He was making it to the water." (Aircraft on fire over Haiphong, pilot severely wounded.)

"He would...concentrate on exactly what he was doing for that particular run."

"Perseverance, the fact that they were willing to take it down in there knowing that there was a possibility of getting wired into a box (canyon) and willing to stay down in the stuff just above gun barrel height." (RESCAP pilot of successful pickup.)

"He was super aggressive." (Pilot successfully destroyed two bridges with Bullpup missiles.)

"He knew that if he didn't get the pictures we would have to go back...so he continued the mission." (After aircraft had been hit.)

C. Stress Capacity

"He was extremely calm...He kept himself under tight control."

"Completely cool...There was no change in his voice or inflection." (In MIG engagement.)

"He remained cool, in command, planning ahead at all times."

"We saw roughly seven missiles launched after the first two...He kept us organized, kept us together."

"Primarily he didn't panic."

"What impressed me most was the coolness of _____ under all this stress."

"He was really good under pressure...He didn't become distracted with his emergency."

"He was cool and he bombed well."

"He would very calmly...roll in toward the SAM, boresight the sight and release his missile."

"...just keeping cool in the situation. He didn't really get excited when the fire control locked on or was tracking or when the guns started tracking."

D. Situation Awareness

"He was completely organized."

"He responded to what we had discussed and briefed. He did it automatically with no conversation."

"He knew the condition of the guy and that he didn't have enough fuel to get back to the beach... He knew that there was no flack in the area."

"He had the ability to sort the information in his mind. He was processing it at a good rate."

"He knew what the hell was going on and reported it very lucidly." (MIG engagement.)

"He gave instructions through an interpreter to the Vietnamese aircraft, coordinated all the operations on the ground, talked to three different Army command posts. His handling of a kind of touchy situation was spectacular."

"He realized that it was a threat but he was able to objectively assess the threat of each missile and keep his scan going."

"It didn't take us ten passes to get the job done when only one or two were required."

E. Procedural Ability

"He had boned up on ECM tactics and could converse in the language we used."

"He had done enough tanking and knew enough about the A-4 that he rolled out right in front of the A-4 in position to tank."

"The whole air wing was engaging MIG's in tail chase. He broke off and started to yo-yo." (Pilot shot down three MIG's.)

"We were at 7500 feet. He saw the first missile... He did a split S through the overcast and the missile went right through us."

"He knew his airplane, knew his weapons systems, and was able to employ the weapons system as required by the situation."

"The fuel management was fantastic. He knew exactly to the letter wnen he had to quit."

"He could effectively use tactics he knew and understood." (Pilot took over mission after scheduled leader was unable to complete flight.)

"He just ran the whole thing (mission) like he had done it all his life in terms of his procedures."

F. Communication

"You knew what was against you, you knew what the odds were, and you knew what you had to do." (Air Boss of CVA.)

"He calmly said, 'Pull up hard now.' I did and the SAM went right under me."

G. Self-Confidence

"He felt he was on top of the problem and so did I."

H. Concern

"That point of responsibility the individual took, which was not a requirement by NATOPS or anything else...very concerned."

II. INEFFECTIVE PERFORMANCE

A. Poor Decision Making Capacity

"This hard charging JG...with a crew...in an aircraft which was not high-performance...with minimum ordnance...chose to enter the fray... As a consequence he got bagged and lost himself, his airplane and his crew...He was attempting to do a job he couldn't do anyway."

"He wanted to find if his trigger was hot so he fogged off a Sparrow missile with no good reason."

"He just didn't think..."

"He wouldn't break a stupid rule to get the job done."

"They pushed right over into it, came out just below where the shooting was, leveled off and got had at...It was a poor decision."

"He certainly made a poor decision considering we had secondary target...Once he got in the air he just decided he was going to the target and the rest of the brief just went to hell."

"He could have taken over from the BN but he didn't."

"He circled the ship at 3000 feet signalling with flashing light...If they were enemy that was the worst move in the world."

"The pilot elected to return to the ship although at the time of takeoff he had insufficient fuel to make it."

"He didn't believe the information they told him and he wouldn't go find out. We just milled around over the Gulf of Tonkin."

"He was picking up heavy ground fire...He said, 'No, we are going to continue.'" (After being instructed to break off by air controller in charge--shot down.)

"It shows me a leader who is not able to make that decision which may not be exactly what his superiors would like to have done but is the most responsible decision at that time." (Flight leader continued strike in poor weather.)

B. Fixation

"He would have attacked anything, even if it were the Battleship New Jersey." (Pilot attached U.S. gunboat.)

"On night missions he was more concerned with keeping the aircraft upright than he was about following navigation, keeping the aircraft in position where he wanted it or being effective." (Pilot worried about getting vertigo.)

"He had made 13 attempts...(All failures)...He was determined to put his sensors in." (Shot down by gunfire.)

"He was looking badly for a kill. Instead of sticking to his formation...he left the formation, running to get his kill." (Shot down.)

"He would get tunnel vision and go in that direction and I don't think he knew what he was going to do when he got there."

G. Procedure Violations

"He didn't bother to ask for permission to light off the ship."

"Even though he was detached he followed lead in... He didn't use his head and follow squadron doctrine."

"He dropped his bombs on safe. He was not pressed for time or anything."

"We were violating our own rules and (CTF) 77 procedures by violating weather minimums."

"He was ignoring all kinds of safety pushing a high-speed jet over in a dive into an overcast without much below."

"You never go over an overcast. It's a good way to get bagged...(This procedure) was out, was it ever out!"

"He did not know if he had to get clearance to fire or not."

D. Lack of Situation Awareness

"He was over-eager to get the target." (Made a 60 degree bomb run at night.)

"I felt I didn't have control of the situation."

"They were unable to put the whole thing in perspective and they were giving credance to possible reactions and threats that were unrealistic."

"Disrespect for the enemy, not proper respect for the enemy's capabilities." (Shot down by ground fire.)

"He wasn't paying attention to what was going on around him."

"He couldn't have been looking at the terrain and his map...He couldn't see the bridge where he thought it should be. From there he proceeded to get more confused."

E. Poor Stress Capacity

"The pilot was scared to death...It shook him up so bad when he got back to the ship, he boltered four times."

F. Lack of Preparation

"At the brief I knew something was going to be wrong. It wasn't detailed or specific...He didn't have the information ready for _____."

"He was not anywhere near set up (to fire missile). He was just lackadaisical I guess."

"He was supposed to be leading a four-plane flight...He didn't know where he was going, he didn't know the terrain, he didn't know anything about it."

G. Over-Confidence

"He was complacent...He felt that he could get down and get pictures you couldn't believe."

"I think he was pushing capability of pilots, airplanes, everything too far there."

H. Lack of Concern

"He pulled off the target, saw the AAA and left his wingman in a hostile area."

I. Excessive Concern with Self Image

"You don't get missions counted if you don't drop bombs...The race was on...He let this interfere with his good judgment."

"He was number one in number of kills...He expected to shoot down in every engagement... He couldn't even dream about his missing another one."

"It was probably a big thing for him to come up and say he didn't have it. He had to prove himself with the old guys in the squadron."

APPENDIX D

PROPOSED STUDENT PILOT EVALUATION FORM

Student's Name_____ Class_____

Instructor's Name_____ Date_____

Circle the number on the rating scale which best describes the student's performance in each area.

	Rating
1. Situation Awareness:	
Integrates inputs from the environment into an accurate conception of the tactical (training) situation.	5
	4
	3
	2
Lacks the ability to integrate inputs from the environment into an accurate conception of the tactical (training) situation; does not properly assess the threat or the risk of his actions.	1
Not observed	0

2. Procedural Ability:

Adapts procedures and tactics to the situation in an effective manner	5
	4
	3
	2
Violates established procedures or disregards proven tactics with insufficient reason for such deviations.	1
Not observed	0

3. Decision Making Capacity:

Has the ability to make logically correct decisions based on the current tactical (training) situation.	5
	4
	3
	2
Either does not make a decision when one is required or makes illogical decisions based on the available information.	1
Not observed	0

4. Determination/Fixation:

Consistent; has the ability to follow a course of action to its logical conclusion.	5
	4
	3
	2
Fixed; concentrates on one aspect of the tactical (training) situation to the exclusion of other sensory inputs.	1
Not observed	0

5. Stress Capacity:

Functions logically and effectively in high stress situations, i.e., calm, does not panic, etc.	5
	4
	3
	2
Does not function logically or effectively in high stress situations, i.e., panics, is excitable, "clutches," etc.	1
Not observed	0

6. Preparation:

Is well prepared for the mission	5
	4
	3
	2
Is not prepared for the mission, i.e., poor navigation planning, lack of tactical intelligence, etc.	1
Not observed	0

7. Self Image:

Has a healthy self image; does not overtly try to impress others	5
	4
	3
	2
Is overly concerned with trying to impress others to the extent that his ability to make tactical (training) decisions is impaired.	1
Not observed	0

8. Self Confidence:

Is confident in his own abilities, but not to the extent of conceit	5
	4
	3
	2
Overestimates his own abilities to the point of exceeding his capabilities.	1
Not observed	0

9. Concern:

Relates to the mission or to the individuals involved in the tactical (training) situation	5
	4
	3
	2
Is unable to relate to the mission or to the individuals involved in the tracitcal (training) situation	1
Not observed	0

10. Communication:

Transmits timely, accurate and concise information.	5
	4
	3
	2
Transmits unreliable, irrelevant, or insufficient information.	1
Not observed	0

LIST OF REFERENCES

1. Reinhardt, R. F., Tucker, G. J., and Haynes, J. M., U.S. Naval Flight Surgeon's Manual, Chapter 6, p. 103, Government Printing Office, 1968.

2. Manual for Use of the Student Pilot Prediction System, Naval Aerospace Medical Research Laboratory.

3. Naval Aerospace Medical Institute Report 1047, Development of an Aviation Combat Criterion--Preliminary Report, by G. M. Rickus and J. R. Berkshire, 1968.

4. Naval Aerospace Medical Research Laboratory Report 1126, Replacement Air Group Performance as a Criterion for Naval Aviation Training, by R. M. Bave, G. M. Rickus and R. K. Ambler, December 1970.

5. Hoffman, D. W., A Method for Predicting Carrier Qualification Success in the Combat Replacement Air Wing, M.S. Thesis, Naval Postgraduate School, Monterey, California, March 1971.

6. Burwell, R. R., "Historical Review of Aircrew Selection--Development of Psychologic Selection of Pilots in the United States Army," Aeromedical Review No. 1-58, Randolph Air Force Base, School of Aviation Medicine, 1957, cf. Armstrong, p.90.

7. Armstrong, H. G., Aerospace Medicine, p. 91, Williams and Wilkins, 1961.

8. Navy Medical Neuropsychiatric Research Unit Report 71-34, Psychiatric and Psychological Research in the Navy before World War II, by W. L. Wilkins, May 1971.

9. Army Air Forces Aviation Psychology Program Reports No. 1, The Aviation Psychology Program in the Army Air Forces, by J. C. Flannagin, p. 12, 1948.

10. Armstrong, p. 92.

11. McFarland, R. A., Human Factors in Air Transportation, McGraw-Hill, 1953, cf. Armstrong, p. 93.

12. Ambler, R. K., U.S. Naval Flight Surgeon's Manual, Chapter 6, p. 633.

13. Jessup, G. and Jessup, H., "Validity of the Eysenck Personality Inventory in Pilot Selection," Occupational Psychology, v. 45, p. 111-123, 1971.

14. Bond, D. D., The Love and Fear of Flying, International Universities Press, 1952.

15. Trites, D. K., and Sells, S. B., "Combat Performance: Measurement and Prediction," Journal of Applied Psychology, v. 41, No. 2, p. 121-130, 1957.

16. Air Force Human Resources Laboratory Technical Report 69-104, Inflight Performance Differences of Pilot and Navigator F-4 Second-Seat Crew Members: A Limited Southeast Asia Combat Evaluation, by F. R. Ratliff and others, July 1969.

17. Naval Aerospace Medical Research Laboratory Report 1158, A New Approach to Criterion Development in the Replacement Air Group, by R. H. Shannon, W. L. Waag and J. C. Ferguson, July 1972.

18. Naval Aerospace Medical Research Laboratory Report 1173, Toward the Development of a Criterion for Fleet Effectiveness in the F-4 Fighter Community, by R. H. Shannon and W. L. Waag, 5 December 1972.

19. Shannon, R. H. and Waag, W. L., Predicting Pilot Success in the F-4 Aircraft, Paper presented at the Aerospace Medical Association, Las Vegas, Nevada, May 1973.

20. Flannagan, J. C., "The Critical Incident Technique," Psychological Bulletin, v. 51, No. 4, p. 327-358, July 1954.

21. Armstrong, p. 103.

22. Dunette, M. P., Personnel Selection and Placement, p. 95-100, Brooks/Cole, 1966.